§213.121 Rail joints

(a) Each rail joint, insulated joint, and compromise joint shall be of a structurally sound design and dimensions for the rail on which it is applied.

(b) If a joint bar on Classes 3 through 5 track is cracked, broken, or because of wear allows excessive vertical movement of either rail when all bolts are tight, it shall be replaced.

(c) If a joint bar is cracked or broken between the middle two bolt holes it shall be replaced.

(d) In the case of conventional jointed track, each rail shall be bolted with at least two bolts at each joint in Classes 2 through 5 track, and with at least one bolt in Class 1 track.

(e) In the case of continuous welded rail track, each rail shall be bolted with at least two bolts at each joint.

(f) Each joint bar shall be held in position by track bolts tightened to allow the joint bar to firmly support the abutting rail ends and to allow longitudinal movement of the rail in the joint to accommodate expansion and contraction due to temperature variations. When no-slip, joint-to-rail contact exists by design, the requirements of this paragraph do not apply. Those locations when over 400 feet in length, are considered to be continuous welded rail track and shall meet all the requirements for continuous welded rail track prescribed in this part.

(g) No rail shall have a bolt hole which is torch cut or burned in Classes 2 through 5 track. [This paragraph (g) is applicable September 21, 1999.]

(h) No joint bar shall be reconfigured by torch cutting in Classes 3 through 5 track.

Application

Rail joints are considered to be a necessary discontinuity and require special attention by railroad maintenance personnel and safety Inspectors.

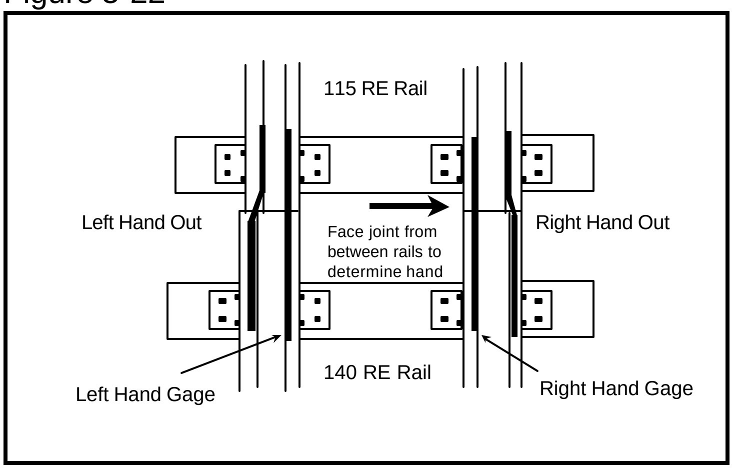
As far as possible, a rail joint should provide the same relative strength, stiffness, flexibility, and uniformity as the rail itself.

- # The TSS recognize these important aspects of rail joints and begin this section with a requirement that rail joints be of a structurally sound design and dimension for the rail on which they are applied.

- # For proper rail-load transfer to occur, rail joints must contact the head and base of rail when the bolts are tight. Many rail-joint designs have been used with varying degrees of success, and the TSS do not attempt to single out any particular design as the only acceptable joint. This would inhibit innovation in modern track design.

- # The TSS only requires structural soundness and bolt condition based on authorized operating train speed. Inspectors must be alert to locations where different rail sections are jointed by rail joints not designed as compromise joints and not identified as fitting both rail sections. Figure 5-22 illustrates the proper application of compromise joint bars.

Figure 5-22



- # For a center-cracked or broken bar, the appropriate corrective action would be replacement or reduction to Class 1 speed under the provisions of §213.9(b). Proper corrective action for a joint bar cracked or broken, other than center break, in Classes 3 through 5 track would be replacement or a reduction to Class 1 or 2. If both joint bars are cracked or broken between the 1st and 2nd bolt hole (including through the 2nd bolt hole) it should be considered Class 1 due to the fact that there is only one effective bolt in that end of the rail.

- # Excessive vertical rail movement within a joint constitutes an exception to the TSS.

- # Track owners are required to maintain the prescribed number of bolts in rail joints.

Track bolts must be of sufficient tightness to allow the joint bars to support the joint firmly, but will not be so tight as to freeze the joint. An Inspector must be aware that a mechanical bolt tightener has the capability to torque the bolt beyond what is required, and thereby freeze the joint.

Paragraph (g) of this section prohibits the use of a rail containing a bolt hole that has been torch-cut or burned in Classes 2 through 5 track.

Paragraph (h) of this section prohibits the reconfiguration of joint bars by torch cutting in Classes 3 through 5 track. By omission of the reference to Classes 1 and 2 track, this practice of reconfiguration is allowed in those Classes. However, the joint bars that are reconfigured by torch cutting must meet certain criteria for structural soundness of design and dimension which is required under (a) of this section.

Rail that has been welded together, either in the field or at a central facility, into lengths exceeding 400 feet are considered continuous welded rail for purposes of applying the requirements of this section.

Defect Codes	
121.01	Rail joint not of structurally sound design and dimension.
121.02	Cracked or broken joint bar in Classes 3 through 5 track (other than center-break).
121.03	Center cracked or broken joint bar.
121.04	Worn joint bar allows excessive vertical movement of rail in joint in Classes 3 through 5 track.
121.05	Less than two bolts per rail at each joint for conventional jointed rail in Classes 2 through 5 track.
121.06	Less than one bolt per rail at each joint for conventional jointed rail in Class 1 track.
121.07	Less than two bolts per rail at any joint in continuous welded rail.
121.08	Loose joint bars.
121.09	Torch-cut or burned-bolt hole in rail in Classes 2 through 5 track.
121.10	Joint bar reconfigured by torch cutting in Classes 3 through 5 track.

§213.122 Torch cut rail

(a) Except as a temporary repair in emergency situations no rail having a torch cut end shall be used in Classes 3 through 5 track. When a rail end is torch cut in emergency situations, train speed over that rail end shall not exceed the maximum allowable for Class 2 track. For existing torch cut rail ends in Classes 3 through 5 track the following shall apply –

(1) Within one year of September 21, 1998, all torch cut rail ends in Class 5 track shall be removed;

(2) Within two years of September 21, 1998, all torch cut rail ends in Class 4 track shall be removed; and

(3) Within one year of September 21, 1998, all torch cut rail ends in Class 3 track over which regularly scheduled passenger trains operate, shall be inventoried by the track owner.

(b) Following the expiration of the time limits specified in (a)(1), (2), and (3) of this section, any torch cut rail end not removed from Classes 4 and 5 track, or any torch cut rail end not inventoried in Class 3 track over which regularly scheduled passenger trains operate, shall be removed within 30 days of discovery. Train speed over that rail end shall not exceed the maximum allowable for Class 2 track until removed.

Application

The regulation prohibits the torch cutting of rail ends in Classes 3 through 5 track except as a temporary repair in emergency situations. In such emergency situations, train speed shall not exceed the maximum allowable for Class 2 track.

Existing torch cuts must be removed from track in the following time frames:

- Class 5 track - by September 21, 1999.

- Class 4 track - by September 21, 2000.

- Class 3 track with passenger trains - by September 21, 1999 all torch cuts shall be inventoried by the track owner. Those torch cuts inventoried will be “grandfathered in” and any torch cuts found after the expiration of one year that are not inventoried must be slow ordered to Class 2 speed and removed within 30 days of discovery. If a railroad chooses to upgrade a segment of track to class 3, and passenger trains are operated, all torch cuts must be removed before speeds can exceed the maximum for Class 2 track. If a railroad chooses to upgrade a segment of track from any class to Class 4 or 5, it must remove all torch cuts.

Defect Codes	
122.01	Torch cut rail applied in Classes 3 through 5 track for other than emergency.
122.02	Failure to remove torch cut rails within specified time frame.
122.03	Failure to remove non-inventoried torch cut rail within 30 days of discovery.
122.04	Train speed exceeds allowable over non-inventoried torch cut rail.

§213.123 Tie plates

(a) In Classes 3 through 5 track, where timber crossties are in use, there must be tie plates under the running rails on at least 8 of any 10 consecutive ties.

(b) In Classes 3 through 5 track no metal object which causes a concentrated load by solely supporting a rail shall be allowed between the base of the rail and the bearing surface of the tie plate. This paragraph (b) is applicable September 21, 1999.

Application

Inspectors should consider this section jointly with the requirements for crossties and rail fastenings and report tie plate conditions as defects where safety is impaired by the absence of tie plates.

In Classes 3 through 5 track, no metal object that causes a concentrated load by solely supporting a rail shall be allowed between the base of rail and the bearing surface of the tie plate. The specific reference to “metal object” is intended to include only those items of track material that pose the greatest potential for broken base rails such as track spikes, rail anchors, and shoulders of tie plates. The phrase “causes a concentrated load by solely supporting a rail” further clarifies the intent of the regulation to apply only in those instances where there is clear physical evidence that the metal object is placing substantial load on the rail base, as indicated by lack of load on adjacent ties.

Defect Codes	
123.01	Insufficient tie plates in Class 3 through 5 track.
123.02	Object between base of rail and the bearing surface of the tie plate causing concentrated load.

§213.127 Rail fastenings

Track shall be fastened by a system of components which effectively maintains gage within the limits prescribed in §213.53(b). Each component of each such system shall be evaluated to determine whether gage is effectively being maintained.

Application

"Rail fastening systems" include modern-day elastic fastening systems, which can consist of abrasion pads, insulator clips, shoulder inserts cast into concrete ties, as well as the fastener itself, of which many different designs are in use today. The fastening system can also be of the traditional cut spike variety, with or without tie plates. The failure of certain critical components within a particular system could adversely affect the ability of the individual fastener to provide adequate gage restraint. The wording of this regulation provides for an evaluation of all components within the system, <u>if necessary</u>, when degradation of the fastening system has resulted in problems maintaining gage within the limits prescribed in §213.53(b).

When an Inspector identifies a gage condition where the fastener system has degraded and the condition meets the factors described below, the Inspector must examine each component of the fastener system (e.g., clip, insulating pad, bolts, spiking pattern, etc.). The Inspector should describe the nature of the failed component(s) on the F 6180.96 form. If a fastener condition causes the gage to exceed the limits of §213.53, the Inspector shall report the condition as a gage defect and describe the nature of the fastener condition on the same defect line of the report.

This section explicitly requires the Inspector to exercise judgment in evaluating the condition of fasteners. The following factors should be considered in the evaluation:

- Gage exceeding the limits of §213.53;
- Gage close to the limits of §213.53 with evidence of recent widening;
- Evidence of recent rapid deterioration of gage with probable continued deterioration;
- Evidence of recent significant damage to rail fasteners to the extent that gage-widening is probable;
- Evidence of recent maintenance work improperly performed resulting in lack of sufficient fasteners to prevent gage-widening under expected traffic;
- Traffic conditions, including speed, tonnage, and type of equipment; and
- Conditions of curvature and grades.

FRA Inspectors may use a Portable Track Loading Fixture (PTLF) described in §213.110 for the purposes of measuring loaded gage to determine adequate gage restraint provided by the fasteners.

Rail anchors or anti-creepers are not considered to be rail fastenings. Rail fastenings that perform a dual function to restrain rail laterally and longitudinally, should only be evaluated on their ability to provide lateral restraint to prevent gage widening in regard to this section.

An insufficient fastener defect should be written when an unsafe condition results from missing or defective fasteners (e.g., heads of cut spikes sheared off at throat) on otherwise sound crossties.

Defect Codes	
127.01	Insufficient fasteners in a 39-foot track segment.

§213.133 Turnouts and track crossing generally

(a) In turnouts and track crossings, the fastenings must be intact and maintained so as to keep the components securely in place. Also, each switch, frog, and guard rail must be kept free of obstructions that may interfere with the passage of wheels.

(b) Classes 3 through 5 track shall be equipped with rail anchoring through and on each side of track crossings and turnouts, to restrain rail movement affecting the position of switch points and frogs. For Class 3 track, this paragraph (b) is effective September 21, 1999.

(c) Each flangeway at turnouts and track crossings must be at least 1-1/2 inches wide.

Application

A turnout is a track arrangement consisting of a switch and frog with connecting and operating parts and extending from the point of the switch to the heel of the frog to allow engines and cars to pass from one track to another. Because of the operating or movable parts and lateral thrust, it is essential that fastenings be in place, tight, and in sound condition.

A crossing is a device used where two tracks intersect at grade permitting traffic on either track to cross the rails of the other. It may consist of four frogs, connected by short rails, or a plant-manufactured diamond. Because of the impact a crossing is subjected to, it is essential that fastenings be in place, tight, and in sound condition.

Each switch, frog, and guard rail must be kept free of obstruction.

Anchors on each side of a turnout or crossing and through a turnout are required on Classes 4 through 5 track. For Class 3 track, this requirement is effective on September 21, 1999. In determining the adequacy of anchors at and on each side of a turnout or crossing and through turnouts, Inspectors should determine the capability of these devices to:

- Restrain rail;
- Assure proper fit of switch points; and
- Prevent line irregularities.

Ties and timbers at switches and crossings must be of sound condition and well-tamped, and the roadbed must be adequately drained.

Flangeways at turnouts and track crossings must be at least 1-1/2 inches wide.

Turnouts must be walked and measurements made before they can be included on the F 6180.96 form as a unit inspected.

Defect Codes	
133.01	Loose, worn, or missing switch clips.
133.02	Loose, worn, or missing clip bolts (transit, side jaw, eccentric, vertical).
133.03	Loose, worn, or defective connecting rod.
133.04	Loose, worn, or defective connecting rod fastening.
133.05	Loose, worn, or defective switch rod.
133.06	Loose, worn, or missing switch rod bolts.
133.07	Worn or missing cotter pins.
133.08	Loose or missing rigid rail braces.
133.09	Loose or missing adjustable rail braces.
133.1	Missing switch, frog, or guard rail plates.
133.11	Loose or missing switch point stops.
133.12	Loose, worn, or missing frog bolts.
133.13	Loose, worn, or missing guard rail bolts.
133.14	Loose, worn or missing guard rail clamps, wedge, separator block, or end block.
133.15	Obstruction between switch point and stock rail.
133.16	Obstruction in flangeway of frog.
133.17	Obstruction in flangeway of guard rail.
133.18	Insufficient anchorage to restrain rail movement.
133.19	Flangeway less than 1-1/2 inches wide.

§213.135 Switches

(a) Each stock rail must be securely seated in switch plates, but care shall be used to avoid canting the rail by overtightening the rail braces.

(d) Each switch point shall fit its stock rail properly, with the switch stand in either of its closed positions to allow wheels to pass the switch point. Lateral and vertical movement of a stock rail in the switch plates or of a switch plate in a tie shall not adversely affect the fit of the switch point to the stock rail. Broken or cracked switch point rails will be subject to the requirements of §213.113, except that where remedial actions C, D, or E require the use of joint bars, and joint bars cannot be placed due to the physical configuration of the switch, remedial action B will govern, taking into account any added safety provided by the presence of reinforcing bars on the switch points.

(c) Each switch shall be maintained so that the outer edge of the wheel tread cannot contact the gage side of the stock rail.

(d) The heel of each switch rail shall be secure and the bolts in each heel shall be kept tight.

(e) Each switch stand and connecting rod shall be securely fastened and operable without excessive lost motion.

(f) Each throw lever shall be maintained so that it cannot be operated with the lock or keeper in place.

(g) Each switch position indicator shall be clearly visible at all times.

(h) Unusually chipped or worn switch points shall be repaired or replaced. Metal flow shall be removed to insure proper closure.

(i) Tongue & Plain Mate switches, which by design exceed Class 1 and excepted track maximum gage limits, are permitted in Class 1 and excepted track.

Application

The TSS under §213.135 specifies the requirements for switch restraint, movement, and fit.

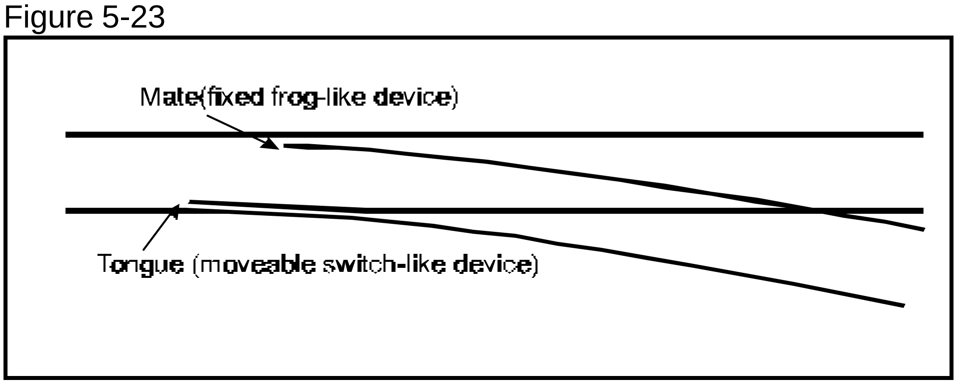
Paragraph (b) considers the existence of reinforcing bars or straps on switch points where joint bars cannot be applied to certain rail defects, as required under §213.113(a)(2), because of the physical configuration of the switch. In these instances, remedial action B will govern, and a person designated under

§213.7(a), who has at least one year of supervisory experience in track maintenance, will limit train speed to that not exceeding 30 m.p.h. or the maximum allowable under §213.9(a) for the appropriate class of track, whichever is lower. Of course, the person may exercise the options under §213.5(a) when appropriate.

The rule does not recommend specific dimensions for determining when switch points are “unusually chipped or worn,” as provided for in paragraph (h). The Accident/Incident data base indicates that worn or broken switch points are the largest single cause of derailments within the general category of “Frogs, Switches, and Appliances.” However, most of these derailments are related also to other causal factors such as wheel flange condition, truck stiffness, and train handling characteristics. Therefore, qualified individuals must evaluate immediate circumstances to determine when switch points are “unusually chipped or worn.”

Paragraph (i) reads, “Tongue and plain mate switches, which by design exceed Class 1 and excepted track maximum gage limits, are permitted in Class 1 and excepted track.” This paragraph provides an exemption for this item of specialized track work, primarily used in pavement or street railroads, which by design does not conform to the maximum gage limits prescribed for Class 1 and excepted track. This type of special work is fabricated from “girder rail” which includes a tram (flangeway) rolled into the rail section. A “mate” is similar to a frog but located on the side of the switch that is equivalent to a straight stock rail. The switch, when in the open or curved position, guides wheels past the mate on the turnout (curved) side in a manner similar to a frog guard rail. Figure 5-23 illustrates the basic components of a tongue and plain mate switch.

Figure 5-23



Typical industry standards call for 4-3/4 inches opening between the switch point and the stock rail, measured at the No. 1 switch rod. As components wear, “lost motion” will result. When the problem of elongated switch clip and/or rod holes are encountered, the switch rods may be adjusted at the clip (e.g., adjustable side jaw clips, rocker clips, etc.). Adjustment may also be

accomplished at the switch stand depending on the design of the assembly. In some cases, lost motion may be compensated by the addition of shims between the switch clip assembly and the switch rail. By adjusting the switch clips, the switch stand, or the application of shims, the amount of switch "throw" or opening may be reduced.

When the opening is substantially less than the standard dimension, wheels can still pass through the switch as intended. However, the back of wheels may contact the inside rail head of the open switch rail. This interaction can cause undesirable lateral pressure against the switch rail. This pressure can contribute to broken heel block bolts, cause cracked or broken switch clips, and break switch crank cross pins. In extreme circumstances, the closed point can open under movement because of the transfer of lateral loads through the switch rods. In these circumstances, Inspectors should make an extra effort to determine the condition of all affected components. The amount of throw is one of the many factors that must be taken into consideration when determining the railroad's compliance with §§213.133 and 213.135.

- At least two tight bolts in each rail are required to ensure that the heel of each switch rail is "secure" for purposes of determining compliance with §213.135(d). One tight bolt in each rail end for Class 1 track is not sufficient to maintain the security of the heel joint. The bolts are not required to be over-tightened which may affect the operation of the switch.

- For hand-operated switch stands of virtually all types, rotary motion imparted to the vertical spindle within the rod of the stand by the person operating the hand lever is translated into (practically) linear movement of the connecting rod by the right angle combination of the end of the spindle beneath the stand and its attached crank. Unless cranks are integral with the spindle by casting during manufacture, they are separate pieces that must be joined. Cranks are attached to spindles in one of two ways: (1) they may be turned into a threaded opening in the side of the spindle or (2) the crank may be fabricated to have a square or rectangular, smooth opening at one end which can be moved from below up onto a spindle having a similar cross section to a position where it can be secured in place by a horizontally-inserted cross pin that simultaneously engages the crank with the spindle. For ease of reference in this discussion, the first case will be referred to as Type A and the second case as Type B. An undesired decoupling of the connecting rod and the switch stand can occur in Type A if the bolt attaching a connecting rod to a threaded crank comes out and, in Type B, separation of the crank and the spindle can occur in the absence of the cross pin. Either instance could result in the gapping of the closed switch point under train movement, unless some other device is in place to physically restrain the points.

Type B switch stands may at times have a plate-like arrangement of sheet metal suspended from the headblock timbers beneath the assembly. (This device, generally a shallow “U” shape, is commonly referred to as a “safety plate.”) The function of the plate, if present, is twofold: (1) to restrict the downward movement of the crank on the spindle, should the cross pin be absent, so the crank does not completely separate from the spindle, and (2) to keep a vertically unrestrained crank from sliding down the spindle far enough to permit the connecting rod enough space below the bottom of the switch stand to move up off the lug of the crank. There have been cases where the cross pin had fractured. The plate itself was found to have been deformed so that the downward displacement of the crank was sufficient to enable the connecting rod to clear the crank lug without contacting the base of the stand. This had lead to decoupling of the switch stand and the connecting rod.

Track Inspectors must constantly bear in mind those aspects of switch stand performance that are crucial to functional safety. This discussion concentrates on that region of the mechanical linkage between the switch points and the switch stand that may be difficult to observe in the course of a turnout inspection.

There are several different styles of Type B switch stands that are in use on main tracks and yards in the railroad industry. These models differ in minor ways. Nevertheless, they rely on the cross pin restraint of the spindle/crank subassembly and they all share vulnerability to the uncoupling of the switch stand and connecting rod. An acceptable turnout inspection must include examination of these partly concealed parts even if such an action has to be carried out manually and with some physical exertion.

Certain designs of switch stands may be fully rotated when the switch lock or keeper is secure and in place. This concern focuses on designs where the switch stand is equipped with an “S” shaped strap, bolted and welded to one of the two flanges of the throw lever stop. The bolt has been proven to be ineffective in preventing rotation of the strap, and the bead weld, placed by the manufacturer at the top of the strap, cracks from repeated depression of the foot latch pedal. The strap rotates downward, altering the location of the lock shackle or keeper, allowing the throw of the switch lever without removal of the lock or keeper. Field personnel speculate that the manufacturer has used an improper welding rod and has cast too short a bead.

If the above types of switch stands are used at switches and derails not requiring securing, the soundness of the strap is not in question. If, however, the track owner requires that the stand be secured by lock or keeper, a weld displaying cracks will call into question the soundness of the latch mechanism and Defect Code 213.135.09, throw lever (potentially) operable with switch lock or keeper in place, should be cited without recommending a violation. If the track owner fails to aggressively address and correct the potential defect on the subject types of switch stands, the Inspector will consider recommending a violation to Chief Counsel. (Recommend a violation only on switch stands where the throw lever operates with lock or keeper in place).

In addition to considering the above criteria, Inspectors must perform the following when inspecting switches:

- Check alinement, gage, and surface.

- Examine condition as to wear of switch points and stock rails.

- See that all bolts, nuts, cotter pins, and other fastenings are in place, in good condition, and are properly tightened.

- See that switch points fit snugly against the rail when the switch is thrown in either position. Request that the railroad representative operate switches to test for lost motion and/or loose connections.

- Examine, if applicable, the rod and fastenings that connect the switch point to the switch circuit controller to ensure they are in place and in good condition.

- Examine the condition and support of spring and power switch machines and hand-thrown switch stands, including automatic or safety switch stands. Stand and machine fastenings to the head block ties must be tight to avoid any movement or play.

- Examine switch-lock, keeper, and foot-lock apparatus.

- Examine condition of switch position indicator and note any unnecessary obstruction to its visibility.

- Examine the heel block, its fastenings, and bars; or, in the absence of a heel block, examine the heel of the switch point.

- Examine the seating of stock rails in the switch plates to ensure that the outer tread of a wheel cannot engage the gage side of these rails and that chairs or braces do not cant these rails in. This defect is particularly a problem for travel in the direction from the frog to the switch (trailing movement). Grease lines or slight groves running at a slight angle on the tread of a stock rail can provide Inspectors with clues about the wheel/rail interface. These marks can be found in the area where wheel treads transition from the switch rail to the stock rail. When found, Inspectors should closely examine the gage side of the stock rail to make sure the outer edge of wheel treads are not contacting the gage side of the stock rail.

- Examine the insulation in the gage plates and switch rods in signal territory.

Defect Codes	
135.01	Stock rail not securely seated in switch plates.
135.02	Stock rail canted by overtightening rail braces.
135.03	Improper fit between switch point and stock rail.
135.04	Outer edge of wheel contacting gage side of stock rail.
135.05	Excessive lateral or vertical movement of switch point.
135.06	Heel of switch insecure.
135.07	Insecure switch stand or switch machine.
135.08	Insecure connecting rod.
135.09	Throw lever operable with switch lock or keeper in place.
135.10	Switch position indicator not clearly visible.
135.11	Unusually chipped or worn switch point.
135.12	Improper switch closure due to metal flow.
135.13	Use of tongue and plain mate where speeds exceed class one

§213.137 Frogs

(a) The flangeway depth measured from a plane across the wheel-bearing area of a frog on Class 1 track may not be less than 1-3/8 inches, or less than 1-1/2 inches on Classes 2 through 5 track.

(b) If a frog point is chipped, broken, or worn more than 5/8-inch down and 6 inches back, operating speed over that frog may not be more than 10 m.p.h.

(c) If the tread portion of a frog casting is worn down more than 3/8-inch below the original contour, operating speed over that frog may not be more than 10 m.p.h.

(d) Where frogs are designed as flange-bearing, flangeway depth may be less than that shown for Class 1 if operated at Class 1 speeds.

Application

The various types of frogs available for specific applications include bolted rigid, solid manganese, self-guarded, rail-bound manganese (RBM), spring rail, movable point, cast, or swing nose. On RBM frogs, the normal wear pattern is in the manganese insert.

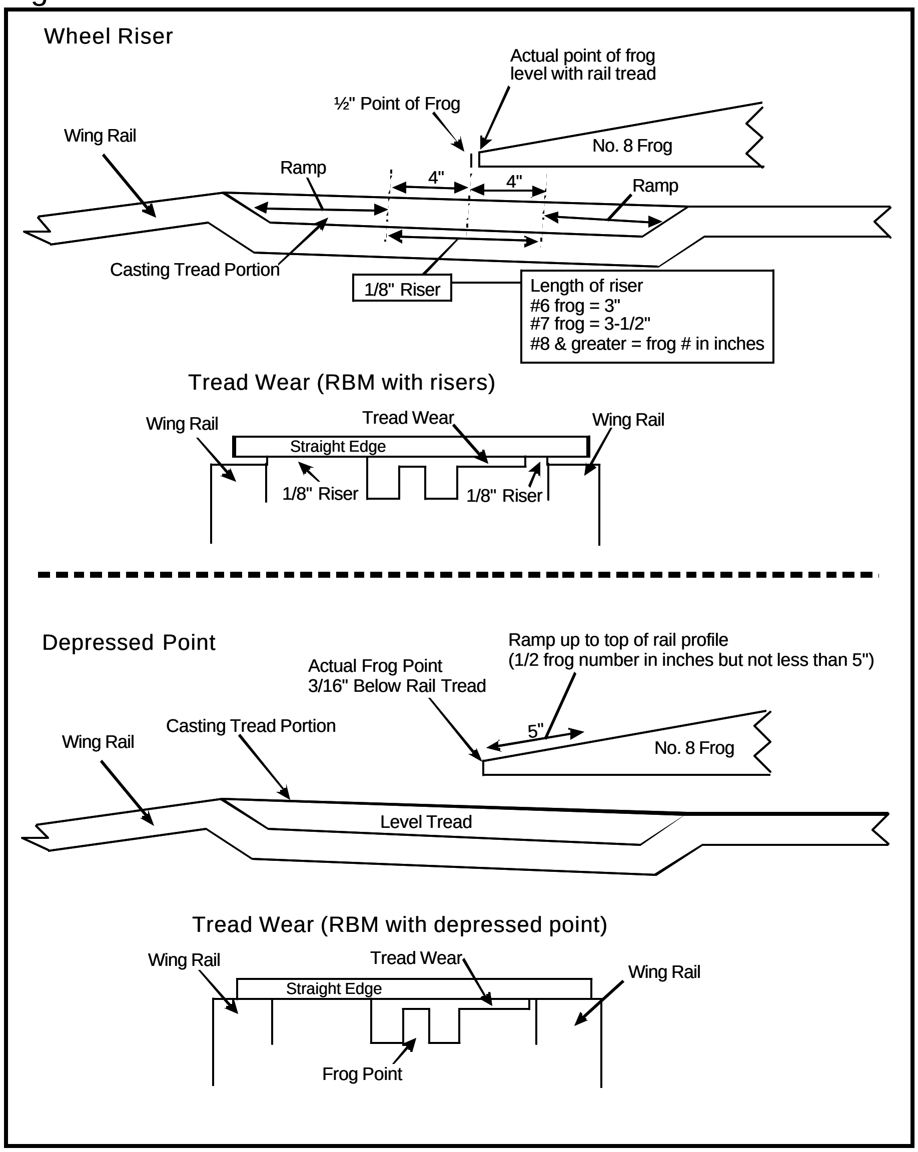
Section 213.137(c) specifically refers to the amount of tread wear from the "original contour" of the casting. The original contour can be determined in a variety of ways depending upon the frog design. For example, for short tread wear depressions in the point 6-inches past the actual point towards the heel of the frog may be measured by placing an 18-inch straight edge longitudinally (see Figure 5.25). In addition, short depressions may be measured in the tread area opposite the frog point by placing the straight edge longitudinally or transversely. Typically, tread wear is measured by placing the straight edge transversely in the point area as shown in Figure 5.24.

As a matter of reference, the tread portion of the casting adjacent to a frog point of an RBM frog may be manufactured to a plane 1/8-inch above the top of the rail profile (wing wheel riser). An alternate RBM frog design incorporates an actual frog point that is 3/16-inch lower than the tread portion. Called a depressed point, the tread will taper up to the top of rail profile in the direction toward the frog heel in a distance equal to one half the frog number in inches but not less than 5 inches. These design characteristics need to be considered when measuring tread wear as discussed below.

The distance from the bottom of the straight edge to the worn tread at the riser is measured. This measurement may be obtained by various types of gauges such as a folding leaf gauge with different degree of taper and a wedge-type gauge. Tape measures are also frequently used to measure tread wear. Figure 5-24 Illustrates the two general types of RBM profiles and the proper method to measure tread wear opposite the frog point.

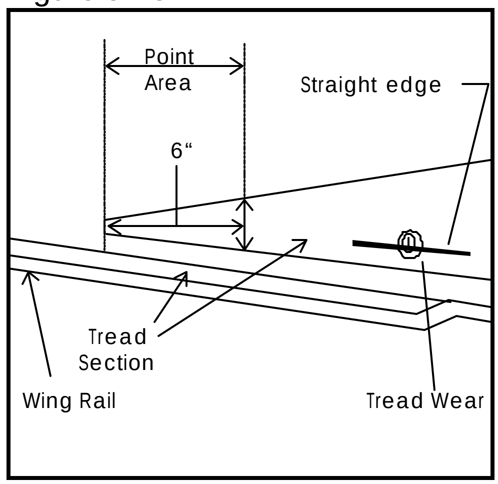
(Intentionally blank)

Figure 5-24



The tread of the frog is considered to be any portion that is contacted by the tread of the wheel except for portion of the frog from the actual point to a position 6 inches back towards the heel [this area is addressed by §213.137(b)]. In the portion of the tread further back than the 6-inch position, measurement may require a longer straight edge or other technique to establish the original contour. Figure 5-25 illustrates a technique to measure a short depression by placing a straight edge longitudinally.

Figure 5-25

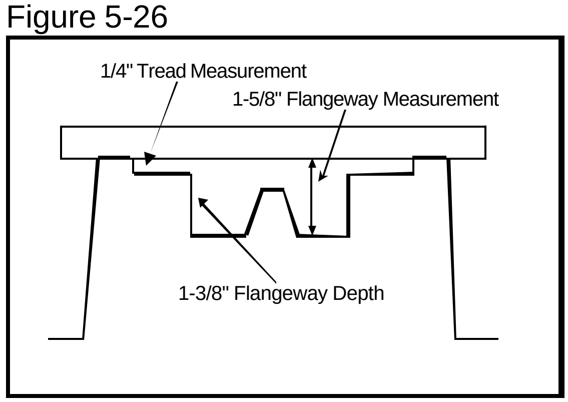


If the tread is worn more than 3/8-inch, the corresponding flangeway depth may also be reaching critical limits. Since the manganese insert is typically designed to be about two inches thick at the wall of the flangeway and about 1-3/8 inches or less at the bottom of the flangeway, wear in this condemning range could result in structural failure of the frog.

Frogs frequently exhibit small spalling (pitting) in the tread. Usually, this type of spalling is not hazardous. Measurements of tread wear should be made over a continuous portion of the tread and not at the bottom of small spalls. However, if the depression is of sufficient size to permit the tread of a wheel to follow that depression, tread wear should be measured at the depression.

To measure flangeway depth, place a straight edge across the frog at the area of concern. Measure the space between the underside of the straight edge to the bottom of the flangeway and the space between the underside of the straight edge and the tread. As shown in Figure 5-26, subtract the tread value from the flangeway value to obtain the actual flangeway depth.

Figure 5-26



When a railroad wheel approaches the frog in the facing direction, the weight of the wheel is supported on the tread of the frog opposite the point until the wheel reaches the transition point about six inches back from the actual point. At this location, the weight is transferred to the frog point.

If a frog point is chipped, broken, or worn more than 5/8-inch down and six inches back, a collapse of the point area is possible with repeated wheel impacts. This parameter requires a defect to be more than 5/8-inch down from the original profile to a location 6 inches back toward the heel to be considered. For example, a frog point that is 7/8-inch below its original profile at the actual frog point and 7/8-inch below at a position 6 inches back toward the heel of the frog would be a defect. For a severe condition that would not meet this criteria such as a breakout at a frog point that is only four inches in length and greater than 5/8-inch down, Inspectors may consider using the Defect Code 213.137.99. While this may not meet the criteria, it is a method to notify a railroad of a condition that the Inspector may feel that the structural integrity of the frog may be in question. Another possible result of a severely worn frog point, especially when coupled with a worn or loose guard rail, is that a railroad wheel may "hit" the point and climb to the wrong side of the frog.

The Association of American Railroads (AAR), Field Manual of Interchange Rules, states that a wheel is condemnable when the flange height is "1-1/2 inches or more above the approximate center line of the tread." The American Railway Engineering and Maintenance-of-way Association (AREMA) Portfolio of Trackwork Plans, Point and Flangeway Dimensions, provides a designed flangeway depth of at least 1-7/8 inches. Therefore, the amount of clearance between a worn wheel with a high flange and the bottom of a new frog's flangeway may be as little as 3/8-inch. At higher speeds, if a worn frog has a flangeway with less than 1-1/2 inches, the wheel flange could "bottom out" in the flangeway and result in severe damage to the frog.

The requirements for flangeway depth in Paragraph (a) and the requirements for tread wear in Paragraph (c) also apply to crossing frogs. Since the designed flangeway depth is also 1-7/8 inches, the safety concerns are therefore the same as excessive wear on the tread portion could result in a wheel flange striking the bottom of the flangeway and causing structural damage to the frog.

Since §213.137(a) permits a flangeway depth of 1-3/8 inches in Class 1 track, contact between a wheel that is approaching condemning limits and the bottom of the flangeway in Class 1 track is possible.

- Paragraph (d) provides an exemption for an item of specialized track work that by design does not conform to the minimum flangeway depth requirements prescribed in paragraph (a) of this section. Called a flange bearing frog, this technology is under consideration as a method of reducing impact loads at frogs. This design is a new concept for track above yard speeds but has been used extensively in light rail transit trackwork.

- An Inspector, in addition to measurements described in the TSS, should see that a frog is supported throughout on sound ties and well-tamped.

- Inspectors must evaluate cracks or breaks in frog castings or rail defects in the non-running portion of wing rails in terms of their potential effect on the safe passage of rolling stock. In particular, when making the evaluation:

  - The Inspector should determine if there is a loss or imminent loss of wheel guidance due to a loss of functional integrity.

  - The Inspector should not consider cracks or breaks in a frog casting that do not affect the safe passage of rolling stock to be a defective condition. If a severe crack, or a series of cracks, creates a condition where the breaking out of a piece of the casting is imminent, the use of Defect Code 213.137.99 should be considered. Cracks or wear that develop into a loss of functional integrity should be addressed by using Defect Code 213.137.02 or 213.137.03 which governs worn frog points and castings.

  - Rail defects in the non-running portion of wing rails should be addressed by using Defect Code 213.137.99.

- Movable (alternative spelling is "moveable") point frogs originated in Europe and have been installed in both conventional and tangential geometry turnouts in this country. Passenger railroads appear to be moving toward the tangential design to attain higher speeds through main track crossovers. Although tangential turnouts and movable point frogs are not widespread throughout the industry and therefore are less-frequently inspected by FRA field personnel than conventional turnouts, these installations are becoming increasingly more common.

  Bolting or fastener designs that fasten the movable point frog to concrete or timber switch ties are considered fasteners in the same manner as cut spikes. Fastenings are discussed under §213.127 of this manual. Bolts that connect movable frog components together are considered frog bolts and must be addressed by using Defect Code 213.133.12, loose or missing frog bolts.

Of paramount importance is a proper fit of the vee point rails against the wing rails on movable frogs. Inspectors must use judgment to determine if the point fits the wing rail properly to allow wheels to pass the frog point. Movements of the wing rail must not adversely affect the fit of the frog point to the wing rail. When an Inspector encounters a condition on a movable frog which should be addressed on the inspection report and no existing Defect Code is available for that condition, Defect Code 213.137.99 will be acceptable with a full description of the condition in the inspection report.

Unlike rail bound manganese frogs, the running surface of most, if not all, movable frogs are made of hardened rail. Inspectors must be aware that this rail may contain defects that require remedial action under §213.113. Asymmetrical rails found in some switch points and frogs must be closely examined during inspections as this appears to be a potential weak spot where a crack or break could occur.

When performing inspections, FRA Inspectors should discuss any concerns about an advanced turnout with appropriate railroad personnel. Inspectors should consult with the Regional Track Specialist to resolve any questions about the safety of these installations.

Defect Codes	
137.01	Insufficient flangeway depth.
137.02	Frog point chipped, broken, or worn in excess of allowable.
137.03	Tread portion of frog worn in excess of allowable.
137.04	Use of flange bearing frog where speed exceeds that permitted by Class 1.
137.99	Severe frog condition not otherwise provided.

§213.139 Spring rail frogs

(a) The outer edge of a wheel tread may not contact the gage side of a spring wing rail.

(b) The toe of each wing rail must be solidly tamped and fully and tightly bolted.

(c) Each frog with a bolt-hole defect or head-web separation must be replaced.

(d) Each spring shall have compression sufficient to hold the wing rail against the point rail.

(e) The clearance between the hold-down housing and the horn may not be more than 1/4-inch.

Application

Inspectors must closely examine every spring rail frog encountered during an inspection. While spring rail frogs have been successfully used for many years, their unique design requires special maintenance attention to avoid derailment hazards to trailing-point train movements on the main track. If a spring wing rail is higher than the top of a frog point, a hollow wheel (or false flange) of a wheel during a trailing move may push on the spring wing rail causing an extreme wide gage. While some spring frogs have a "relief" groove built into the frog for this purpose, Inspectors must be acutely aware of any signs of the gage side of a spring wing rail being struck by the outer edge of wheel treads.

The toe of each spring rail frog must be solidly supported, and proper hold-down housing clearance must be maintained to avoid excessive vertical movement of the wing rail. The first sign that this is occurring will be gouging on the gage corner of the wing rail behind the point of frog. Wheel gouging must not be confused with channeling in the spring wing rail that is incorporated at the time of manufacture to accommodate wheel tread transition.

If the toe is not solidly tamped and excessive horn and housing clearance exists, the wing rail may have vertical motion operating on the point rail in a trailing-point movement and the forces on the wing rail will cause the wing rail to move laterally, allowing the wheel to drop in at the throat of the frog.

Due to the unique design characteristics of spring frogs, turnouts with this type of appliance require special consideration in regard to guard rails. On the parent or main track side of a turnout when trains are not "springing" the frog (by design) and operating on an unbroken path, an extra length guard rail assures a proper path for wheel sets. This guard rail is designed to keep wheels off the spring wing rail from the point where this rail is "hinged" through the frog throat and finally to the actual frog point.

While the TSS does not address this design concept, Inspectors should be aware of this attribute of spring frogs. If a standard length guard rail is used or a long guard rail is improperly installed, any lateral wheel forces can cause significant problems. Specifically, the guard rail and other frog elements will quickly deteriorate, and in extreme circumstances, the wing rail can open while trains are moving through the main track side which can result in an unprotected wide gage condition.

Another special consideration with regard to spring frogs is the longitudinal relationship between the spring wing rail and frog point. If a turnout has insufficient rail anchors to restrain longitudinal movement, the wing rail may not function properly. Inspectors are reminded to refer to §213.133 (b) which

requires Classes 3 through 5 track to be equipped with sufficient rail anchoring. If insufficient anchors are causing a problem at Class 1 and 2 track, Inspectors are encouraged to note this condition and inform the railroad.

Spring frogs are manufactured with a steel base plate. Attached to the base plate are clip plates, which are placed along the fixed side of the frog. The clip plates, which are shaped at a right angle, are attached to the base plate by bolts, welds, or both. Frog bolts are placed through the body of the frog and through the vertical portion of the clip plates and tightened. This holds the body of the frog to the clip plate assembly.

There are no gage-holding fasteners along the movable side of the frog as they would interfere with the spring wing rail. Therefore, it can be seen that the frog bolts and clip plate assemblies acting together maintain alinement of the spring frog. Care should be taken to insure that frog bolts and clip plate bolts are in place and tight (Defect Code 213.133.12). Also check clip plates to see if welds are cracked or broken and check clip plates for cracks and breaks at the corner where the plate bends from horizontal to vertical. Where cracks or breaks in clip plates affect the fastening of the frog to the base plate use Defect Code 213.127.01 (insufficient fasteners).

Defect Codes	
139.01	Outer edge of wheel contacting side of spring wing rail.
139.02	Toe of wing rail not fully bolted and tight.
139.03	Ties under or wing rail not solidly tamped.
139.04	Bolt-hole defect in frog.
139.05	Head and web separation in frog.
139.06	Insufficient tension in spring to hold wing rail against point rail.
139.07	Excessive clearance between hold-down housing and horn.

§213.141 Self-guarded frogs

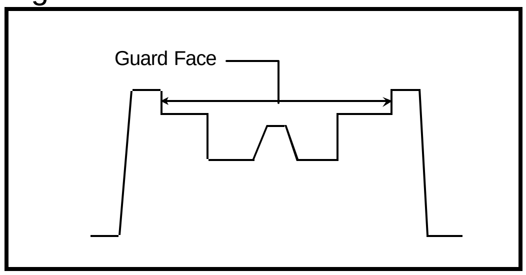
(a) The raised guard on a self-guarded frog may not be worn more than 3/8 of an inch.

(b) If repairs are made to a self-guarded frog without removing it from service, the guarding face must be restored before rebuilding the point.

Application

When examining frogs, observe the condition of the frog point and where there is evidence of wear caused by wheel flanges contacting the frog point, take measurements to determine compliance with this section. To determine the amount of wear on a raised guard, measure the thickness at a portion where there is wear. Compare this measurement to a portion where there is no wear and the difference between the two is equivalent to the amount of wear. Figure 5-27 illustrates guard face on a self guarded frog.

Figure 5-27



During repairs of a self-guarded frog, it is imperative that the raised guarding face is restored before the actual frog point. This precaution is necessary due to the potential for a wheel flange striking the frog point.

Self guarded frogs are designed for use in low speed track and their use in tracks where speeds exceed 20 m.p.h. can result in excessive lateral forces such as wheels "kicking" or in extreme cases wheels climbing up the raised guard. The TSS does not prohibit the use of self guarded frogs for specific speeds, however, Inspectors are encouraged to inform a railroad of the potential for problems that may occur if a self guarded frog is found in a track where speeds exceed 20 m.p.h.

Defect Codes	
141.01	Raised guard worn excessively.
141.02	Frog point rebuilt before restoring guarding face.

§213.143 Frog guard rails and guard faces; gage

The guard check and guard face gages in frogs must be within the limits prescribed in the following table:

Class of track	**Guard check gage** The distance between the gage line of a frog to the guard line[1] of its guard rail or guarding face, measured across the track at right angles to the gage line[2], may not be less than	**Guard face gage** The distance between guard lines[1], measured across the track at right angles to the gage line[2], may not be more than
1	4' 6-1/8"	4' 5-1/4"
2	4' 6-1/4"	4' 5-1/8"
3 & 4	4' 6-3/8"	4' 5-1/8"
5	4' 6-1/2"	4' 5"

1 - A line along that side of the flangeway which is nearer to the center of the track and at the same elevation as the gage line.

2 - A line 5/8-inch below the top of the centerline of the head of the running rail or corresponding location of the tread portion of the track structure.

Application

A guard rail is installed parallel to the running rail opposite a frog to form a flangeway with the rail and thereby to hold wheels of equipment to the proper alinement when passing through the frog.

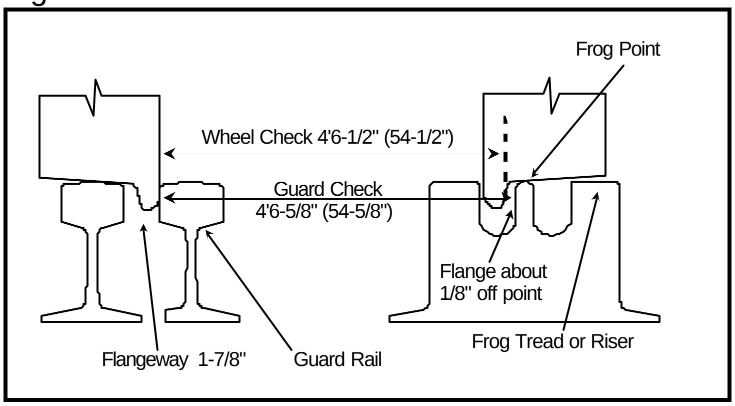
A guard rail must be maintained in the proper relative position to the frog in order to accomplish its important intended safety function. Inspectors should examine guard rails carefully to see that they are adequately fastened, and when measuring guard rail gage, fully consider any movement of guard rail or frog under traffic conditions.

Section 213.143 clearly specifies allowable tolerances for guard check and guard face gage for various classes of track.

When measuring guard check gage, it is important to consider the path of wheels through the frog because the function of a guard rail is to keep wheel flanges from striking the actual frog point. As reference, standard check gage on a railroad wheel set is approximately 54-1/2 inches. While guard check

gage less than wheel check gage is permitted by the TSS for lower classes of track, the condition of the actual frog point in relation to the path of wheels through a frog is a good indicator of the effectiveness of a guard rail. For general reference, Figure 5-28 illustrates approximate design check gage values:

Figure 5-28

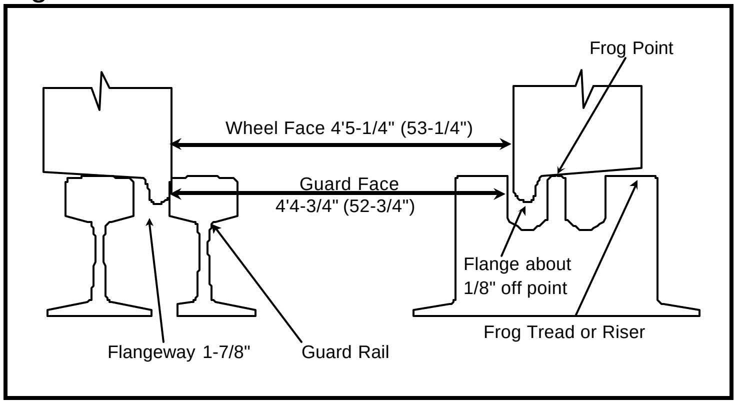


The critical area where guard check gage must be measured is at the actual point of frog. Inspectors must also consider any unusual wear that may exist at the actual frog point and position the track gauge or other measuring device accordingly.

Face gage is a dimension that becomes critical when the distance between two opposing guard rails or a guard rail and a frog wing rail become larger than the distance between the back of wheel sets. This would occur by improper installation or a condition such as a severe alinement defect. Normally, face gage would be measured in the same vicinity as check gage. However, Inspectors should consider measuring face gage at other points in special trackwork where there may be an indication that wheels are being “pinched.”

For general reference, the Figure 5-29 illustrates approximate design face gage values.

Figure 5-29



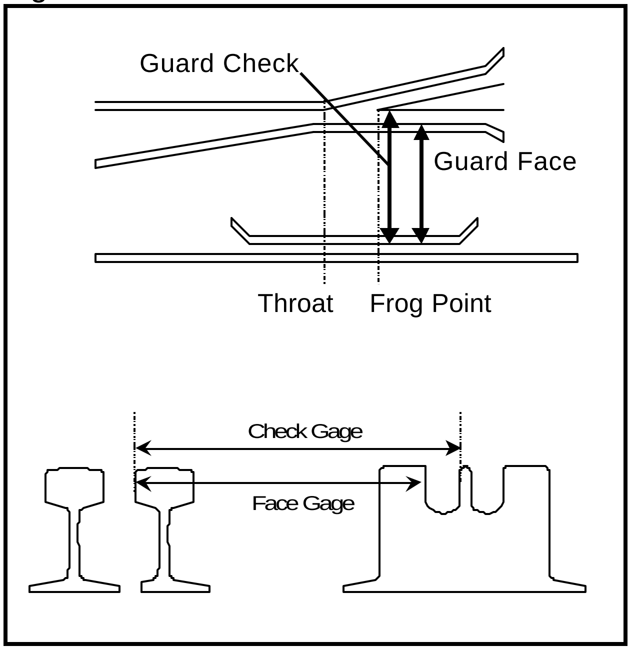
Broken guard rails occur infrequently, since they do not support the vertical wheel loads of passing trains. When evaluating a crack or break in a guard rail, the Inspector should be aware that cracks or breaks exist which do not affect the ability of the guard rail to function as intended. If the integrity of the guard rail is affected, the Inspector will cite the defect using Defect Code 213.143.03, Cracked or Broken Guard Rail.

There are many different types and designs of frog guard rail designs. Some guard rail plates are recessed to seat the running rail while others are flat. Some guard rail plates are punched with spike hole slots; others are not. Other guard rails are bolted to the running rail. On some railroads, it is normal practice not to spike the gage side of the running rail through the guard rail area while some guard rail plates do not have holes punched for this purpose. FRA has no record of serious safety problems that have developed as a result of not spiking the running rail through the guard rail area.

If encountering a problem whereby the running rail has moved to create an unsafe condition, the Inspector should use "insufficient fasteners" Defect Code (213.127.01). Inspectors should discuss unique situations with their Track Specialist.

While not a requirement of the TSS, guard rails have a straight portion that guides wheels through the area from the "throat" to the actual frog point. If Inspectors find a guard rail where the straight portion does not encompass this area, Inspectors should bring this to the attention of the railroad. Figure 5-30 illustrates the proper measurement points to determine check/face gage compliance and shows the proper longitudinal relationship between a guard rail and frog point.

Figure 5-30



Defect Codes	
143.01	Guard check gage less than allowable.
143.02	Guard face gage exceeds allowable.
143.03	Cracked or broken guard rail.